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ZIRCONIUM

The rapid advancement of metallurgy in recent years has created a demand for many metals that heretofore had little industrial application. These versatile metals of which zirconium is typical, are in particular demand as structural materials in the fields of atomic energy. Of no less future importance, however, is the part zirconium will probably play in the development of high temperature alloys for rockets and jet engines. The rapid growth in production of this metal illustrates the increased awareness of industry to the unusual combination of properties found in zirconium. In 1945 the total United States production of zirconium amounted to 20 pounds. In 1952 production had risen to several hundred thousand pounds and each succeeding year the usefulness of this metal becomes more apparent.

Pure crystalline zirconium is a silver-white metal resembling freshly broken cast iron. The pure metal has a specific gravity of 6.5 and is ductile and malleable. Zirconium has an atomic weight of 91.22; atomic number of 40; melting point of 1845°C; and valence of 2, 3, 4, or 5, with 4 being the most common. At ordinary temperatures zirconium is chemically inert and thus will resist tarnishing. Hafnium, atomic number 72, is a constant associate of zirconium because of the almost identical atomic radii of these two elements and their chemical similarity. Thorium and the rare-earth elements frequently are included in zirconium minerals.

Zirconium has been estimated to constitute 0.02 to 0.03 percent of the earth's crust. It ranks twentieth among the elements in abundance, being more plentiful than nickel, copper, zinc, and lead. Zircon (zirconium silicate) and baddeleyite (zirconium oxide) are the only zirconium minerals occurring abundantly and used as ores. Zirconium lines have been identified in the spectrum of the sun and stars, indicating its presence in these bodies. Zircon is a common constituent of many rocks, particularly granites, syenites and diorites, and of sands resulting from the disintegration of igneous rocks. The so-called black sands, consisting of minerals of high specific gravity, many of which are dark, are commonly rich in minute zircon crystals. Sedimentary rocks often contain zircon because the mineral is hard and chemically resistant to weathering. It occurs more rarely in granular limestones, schists, and gneisses.

Zircon is essentially a silicate of zirconium containing a variable amount of hafnium. The hafnium oxide content varies up to 4 percent in most zircon. Zircon crystallizes in the tetragonal system, and occurs in square prisms and in irregular forms and grains. It is very hard (7.5 on Mohs scale of hardness, where a steel knife blade is 5.5 and quartz is 7); transparent to opaque; and colorless, yellowish, grayish, or reddish-brown. Zircon has an imperfect cleavage, an adamantine luster, a conchoidal fracture, and a specific gravity ranging from 4.6 to 4.7.

As a mineral in sands, zircon is unlike quartz, being brilliant and having a higher specific gravity. It is insoluble in hydrofluoric acid. Ultra-violet light causes many specimens of zircon to fluoresce a brilliant orange, red, or yellow, a phenomenon which has been attributed to the presence of hafnium or uranium in the mineral.

Flawless, transparent zircons are used as gemstones because they are beautiful, durable and fashionable. Zircons have a high index of refraction and great dispersive power, which produce brilliance and "fire" (flashes of different colors when the zircon is viewed at various angles). The relative abundance of gem-quality zircon has made it comparatively inexpensive. It occurs colorless (jargon or "Matura diamond"), yellowish-red (jacinth) and reddish-orange (hyacinth). Certain brown Siamese zircons when heated change to a blue-green either permanently or temporarily. Australian, Ceylonese, and Siamese gem gravels are the principal sources of gem-quality zircon.

The largest producers of industrial zircon and baddeleyite at present are Australia and Brazil, although there are many other potential sources. Baddeleyite is frequently preferred in industry where the oxide may be utilized directly in manufacturing processes. Baddeleyite is found principally in Brazil, where it occurs in pegmatites, old